PERSPEKTIVEN FÜR UMWELT & GESELLSCHAFT umweltbundesamt

Austria's National Air Emission Projections 2010–2020

Submission under the UN/ECE Convention on Long-Range Transboundary Air Pollution

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

AUSTRIA'S NATIONAL AIR EMISSION PROJECTIONS 2010–2020

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REPORT
REP-0260

Vienna, 2010

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Acknowledgment

The authors of this report want to express their thanks to all experts involved in the preparation of this report. All work for the preparation for this report has been carried out within the project EMIPRO at Umweltbundesamt.

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http://www.umweltbundesamt.at/

Imprint

Owner and Editor: Umweltbundesamt GmbH
Spittelauer Lände 5, 1090 Vienna/Austria

Printing by: Umweltbundesamt GmbH

Printed on CO_2-neutral 100% recycled paper

ISBN 978-3-99004-061-4

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ZUSAMMENFASSUNG

Der vorliegende Report aktualisiert die österreichischen Emissionsprojektionen für die Luftschadstoffe Schwefeldioxid (SO_2), Stickoxide (NO_x), flüchtige organische Verbindungen ohne Methan (NMVOC) und Ammoniak (NH_3). Das Szenario berücksichtigt implementierte Maßnahmen, nicht aber Maßnahmen im Planungsstadium.

Das dargestellte Emissionsszenario basiert auf denselben energiewirtschaftlichen Grundlagendaten von WIFO, Österreichischer Energieagentur und TU Wien, die für die Projektionen der Treibhausgasemissionsentwicklung herangezogen wurden. Energiewirtschaftliche Grundlagendaten für Österreich, in denen die Auswirkungen der aktuellen Finanz- und Wirtschaftskrise auf die künftige Entwicklung abgebildet werden, lagen zu Beginn des Projektes im Herbst 2009 nicht vor. Da die verwendeten Grundlagendaten auf der Energiestatistik 2007 basieren, sind seitdem erfolgte Aktualisierungen der Energiestatistik nicht berücksichtigt.

Insbesondere für das Jahr 2010 sind die Projektionen deshalb mit erheblichen Unsicherheiten behaftet. Aufgrund der aktuellen Wirtschaftskrise ist insbesondere bei den Aktivitätsdaten in den Bereichen Sachgüterproduktion, Energieaufbringung und (Güter-)Verkehr mit z. T. signifikant abweichenden Werten im Vergleich zu dem vorliegenden Szenario zu rechnen. Dies legt nahe, dass die Emissionen des Jahres 2010 in diesem Szenario überschätzt werden. Eine quantitative Analyse der Abweichung liegt derzeit allerdings nicht vor.

Im Rahmen des UNECE-Übereinkommens über weiträumige grenzüberschreitende Luftverunreinigung (Long-Range Transboundary Air Pollution, LRTAP) sind neben den Inventurdaten zu den Luftschadstoffen auch Emissionsprojektionen zu berichten.

Bei einigen Schadstoffen macht es einen erheblichen Unterschied, ob die Emissionen anhand der verkauften Treibstoffmengen oder anhand der tatsächlich im Inland verbrauchten Treibstoffmengen berechnet werden. Nach den Leitlinien des Übereinkommens sollen die Emissionen basierend auf den verkauften Treibstoffmengen berechnet werden, zusätzlich kann die Abschätzung auf Grundlage der verbrauchten Treibstoffmengen erfolgen. Im Folgenden werden für Österreich beide Berechnungsmethoden wiedergegeben.

Nationale Gesamtemissionen

Die folgende Tabelle zeigt die aktualisierten Projektionen für 2010 im Vergleich zu den nationalen Gesamtemissionen für die Jahre 1990, 2000, 2005 und 2007 (UMWELTBUNDESAMT 2008), gemäß dem UNECE-Übereinkommen über weiträumige grenzüberschreitende Luftverunreinigung (Stand: Dezember 2008).

Tabelle: Nationale Gesamtemissionen für 1990, 2000, 2005, 2007 und projizierte Emissionen für 2010 [kt/a] auf Basis der verkauften Treibstoffmengen.

Luftschadstoff	Österreichische Emissions-Inventur 2008				projizierte Emissionen
	1990	**2000**	**2005**	**2007**	**2010**
NO_x	192,51	204,45	239,62	220,10	198,75
SO_2	74,34	31,64	27,19	25,60	25,80
NMVOC	273,64	176,04	178,71	179,81	167,70
NH_3	71,18	69,25	66,11	66,41	61,45

Diese nationalen Gesamtemissionen wurden auf Basis der in Österreich verkauften Treibstoffe errechnet. Dabei ist zu beachten, dass in Österreich in den letzten Jahren ein beachtlicher Teil der verkauften Treibstoffmenge im Inland getankt, jedoch im Ausland verfahren wurde (preisbedingter Kraftstoffexport).

Tabelle: Österreichs Emissionsprojektionen für 2010, 2015 und 2020 auf Basis der verkauften Treibstoffmenge [kt/a].

	2010	**2015**	**2020**
NO_x	198,75	158,80	129,66
SO_2	25,80	24,53	23,63
NMVOC	167,70	172,45	179,08
NH_3	61,45	61,13	61,01

Tabelle: Österreichs Emissionsprojektionen auf Basis der verbrauchten Treibstoffmenge [kt/a].

	2010	**2015**	**2020**
NO_x	146,20	125,44	110,63
SO_2	25,75	24,48	23,57
NMVOC	164,31	169,15	176,13
NH_3	61,31	61,04	60,93

Der Vergleich zeigt, dass der preisbedingte Kraftstoffexport für NO_x-Emissionen von maßgeblicher Bedeutung ist.

NO_x-Trend

Die Hauptquelle der nationalen NO_x-Emissionen ist der Sektor Energie mit einem Anteil von mehr als 95 %. Im Sektor Energie zählt der Straßenverkehr mit einem Anteil von mehr als 50 % an den Gesamtemissionen zu den Hauptverursachern.

Die Projektionen zeigen eine beachtliche Reduktion der Emissionen bis 2020, hauptsächlich bedingt durch eine Reduktion der Verkehrsemissionen der schweren Nutzfahrzeuge und der Pkw. Hauptverantwortlich hierfür sind die Modernisierung der Flotte, die gemessenen geringeren spezifischen Emissionen von Pkw und schweren Nutzfahrzeugen der neuesten Abgasklasse sowie die – auf Basis der gesetzlich festgelegten Typprüfgrenzwerte – geschätzten, weiter sinkenden spezifischen NO_x-Emissionen von Kraftfahrzeugen der künftigen Abgasklassen. Es sei allerdings angemerkt, dass in der Vergangenheit die realen Emissionen im Straßenverkehr nicht so stark gesunken sind wie die auf Typprüfgrenzwerten basierenden Emissionsprojektionen hatten erwarten lassen.

SO_2-Trend

Die Reduktion der SO_2-Emissionen in der Vergangenheit ergab sich hauptsächlich durch die Einführung von Emissionsgrenzwerten in der Energieerzeugung und durch die Reduktion des Schwefelgehaltes in Mineralöl-Produkten. Die Projektionen zeigen einen nur mehr geringen Emissionsrückgang bis 2020.

NMVOC-Trend

Die Hauptquellen der nationalen NMVOC-Emissionen sind der Sektor Energie und Lösemittel, wobei mehr als 50 % der Gesamtemissionen von Lösemittelanwendungen verursacht werden. Seit 1990 kam es zu einer beträchtlichen Reduktion der NMVOC-Emissionen in den genannten Sektoren.

Die Projektionen zeigen längerfristig einen Emissionsanstieg durch steigenden Lösungsmitteleinsatz, der durch die Emissionsminderungen aufgrund der Verbesserung von Antriebstechnologien im Verkehrssektor und dem Trend hin zu Zentralheizungen und niedrigeren Emissionsfaktoren von Neuanlagen im Sektor Raumwärme nicht kompensiert werden kann.

NH_3-Trend

Hauptquelle der NH_3-Emissionen in Österreich ist der Sektor Landwirtschaft mit einem Anteil von mehr als 95 % der Gesamtemissionen. Die NH_3-Emissionen verzeichnen einen leichten Rückgang seit 1990.

Die Projektionen weisen für die Zeit nach 2010 nahezu unveränderte Emissionen aus.

1 INTRODUCTION

This report presents emission projections "with measures" for 2010, 2015 and 2020. It includes background information to enable a quantitative understanding of the key socioeconomic assumptions used in the preparation of the projections.

Emission projections in this report are based on economic scenarios that were developed before the current financial and economic crisis. Therefore, recent economic developments are not taken into account in the emission projections presented here. Emissions from energy related sectors are calculated on the basis of an energy forecast from 2008, thus recent updates in the energy statistics are not accounted for in these projections.

For comparison, this report also includes emission data from the 2008 National Air Emission Inventory – data status as of December 2008 (UMWELTBUNDESAMT 2008).

2 EMISSIONS

In the Emission Reporting Guidelines 2002, Parties are given the choice of whether to report emissions on the basis of fuel used or fuel sold to the final consumer. It is recommended that they state clearly in their submissions the basis of their calculations. Table 1 shows national total emissions and projections under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP), based on fuel sold.

Table 1: Austrian national total emissions for 1990, 1995, 2000, 2005 and projected emissions for 2010 after implementation of agreed policy for Austria in 1 000 tons per year, i.e. [kt/a], based on fuel sold.

	1990	2000	2005	2007	2010
Pollutants	**Austrian Emission Inventory 2008 [kt]**				**Projection Emissions [kt]**
NO_x	192.51	204.45	239.62	220.10	198.75
SO_2	74.34	31.64	27.19	25.60	25.80
NMVOC	273.64	176.04	178.71	179.81	167.70
NH_3	71.18	69.25	66.11	66.41	61.45

If fuel prices are considerably different from those in neighbouring countries, fuel tends to be bought in the country where it is cheaper and consumed in another Member State (fuel export in the vehicle tank or so-called 'tank tourism'). Austria has experienced a considerable amount of fuel export in the vehicle tank in the last years; this needs to be taken into account when reporting emissions for Austria. Most of these fuels are currently used in heavy duty vehicles for long-distance traffic (inside and outside the EU). According to the Emission Reporting Guidelines, emissions from road vehicle transport should therefore be calculated and reported on the basis of fuel sold and, additionally, may be reported based on fuel used. Austria reports its projected emissions calculated on the basis of both methods.

Table 2: Austria's emission projection based on fuel sold [kt/a].

	2010	2015	2020
NO_x	198.75	158.80	129.66
SO_2	25.80	24.53	23.63
NMVOC	167.70	172.45	179.08
NH_3	61.45	61.13	61.01

Table 3: Austria's emission projection based on fuel used [kt/a].

	2010	2015	2020
NO_x	146.20	125.44	110.63
SO_2	25.75	24.48	23.57
NMVOC	164.31	169.15	176.13
NH_3	61.31	61.04	60.93

The comparison shows that fuel export in the vehicle tank is of significant relevance for the NO_x emission ceiling only.

2.1 Nitrogen Oxides NO_x

The main source of NO_x emissions in Austria, with a share of more than 95%, is fuel combustion. Within this source road transport accounts for the highest contributions to total NO_x emissions; over the years more than 50% of total national emissions have arisen from this source.

The projections based on current legislation show a remarkable reduction of NO_x emissions, mainly due to a decrease of transport emissions. NO_x emissions, mainly from heavy duty vehicles and cars, are projected to decrease. The main reasons for this decrease are the modernisation of the vehicle fleet, the measured lower specific emissions from cars and heavy duty vehicles of the latest emission class and the estimated – based on statutory emission limits – further decrease of specific emissions from motor vehicles of future emission classes. It should, however, be noted that in the past real life emissions from road transport did not decrease as much as projected (on the basis of type approval limit values).

Total national emissions based on fuel sold are expected to decrease to 130 kt in 2020, emissions based on fuel used to 111 kt.

Table 4: Austria's NO_x emission projection.

	NEC Gas Source Categories	NO_x [kt]				
		1990*	**2007***	**2010**	**2015**	**2020**
	National Total (fuel sold)	192.51	220.10	198.75	158.80	129.66
	National Total (fuel used)	179.28	162.59	146.20	125.44	110.63
1	Energy	168.29	155.56	140.62	119.80	104.96
1.A	Fuel Combustion Activities	168.29	155.56	140.62	119.80	104.96
1.A.1	Energy Industries	17.78	14.60	14.12	13.76	14.22
1.A.2	Combustion in Manufact. Industry	32.80	32.29	30.86	31.77	33.99
1.A.3	Transport (fuel used)	89.96	83.99	69.79	50.77	35.37
1.A.4	Other Sectors	27.68	24.60	25.76	23.42	21.30
1.A.5	Other	0.07	0.09	0.08	0.08	0.09
1.B	Fugitive Emissions	IE	IE	IE	NA	NA
2	Industrial Processes	4.80	1.71	0.52	0.54	0.57
2.A	Mineral Products	NA	NA	NA	NA	NA
2.B	Chemical Industry	4.07	0.34	0.50	0.52	0.55
2.C	Metal Production	0.17	0.11	0.02	0.02	0.02
2.D	Other Production	0.55	1.26	IE1	IE	IE
2.G	Other	NA	NA	NA	NA	NA
3	Solvent and other Product Use	NA	NA	NA	NA	NA
4	Agriculture	6.09	5.27	5.01	5.04	5.05
4.B	Manure Management	NA	NA	3.99	3.97	3.96
4.C	Rice Cultivation	NO	NO	NO	NO	NO
4.D	Agricultural Soils	6.06	5.23	0.94	0.99	1.01
4.F	Field Burning of Agric. Residues	0.04	0.03	0.04	0.04	0.04
4.G	Other	NA	NA	0.05	0.05	0.05
6	Waste	0.10	0.05	0.05	0.05	0.05
6.A	Solid Waste Disposal on Land	NA	NA	NA	NA	NA
6.B	Wastewater Handling	NA	NA	0.00	0.00	0.00
6.C	Waste Incineration	0.10	0.05	0.05	0.05	0.05
6.D	Other Waste	NA	NA	NA	NA	NA
I.B.	Aviation (cruise)	2.44	7.99	8.41	9.95	11.49

* *Data source: Austrian Emission Inventory 2008*

[1] *included in 1.A.2f*

IE … included elsewhere; NA… not applicable; NO … not occurring

2.2 Sulphur Dioxide SO_2

SO_2 emissions show a significant reduction from 1990 to 2007 mainly because of the implementation of emission limits in the power generation sector and the reduction of the sulphur content in mineral oil products.

No further significant reductions of total SO_2 emissions are expected until 2020.

Table 5: Austria's SO_2 emission projection.

	NEC Gas Source Categories	SO_2 [kt]				
		1990*	**2007***	**2010**	**2015**	**2020**
	National Total (fuel sold)	74.34	25.60	25.80	24.53	23.63
	National Total (fuel used)	73.67	25.55	25.75	24.48	23.57
1	Energy	71.37	24.27	24.75	23.47	22.56
1.A	Fuel Combustion Activities	69.37	24.09	24.59	23.33	22.43
1.A.1	Energy Industries	14.04	5.97	4.54	3.84	3.54
1.A.2	Combustion in Manufact. Industry	17.89	11.17	10.70	11.27	11.84
1.A.3	Transport (fuel used)	4.48	0.27	0.28	0.30	0.32
1.A.4	Other Sectors	32.95	6.66	9.06	7.90	6.71
1.A.5	Other	0.01	0.01	0.01	0.02	0.02
1.B	Fugitive Emissions	2.00	0.18	0.16	0.15	0.13
2	Industrial Processes	2.22	1.22	0.95	0.95	0.95
2.A	Mineral Products	NA	NA	NA	NA	NA
2.B	Chemical Industry	1.56	0.77	0.55	0.55	0.55
2.C	Metal Production	0.66	0.46	0.40	0.40	0.40
2.D	Other Production	NA	NA	NA	NA	NA
2.G	Other	NA	NA	NA	NA	NA
3	Solvent and other Product Use	NA	NA	NA	NA	NA
4	Agriculture	0.00	0.00	0.00	0.00	0.00
4.B	Manure Management	NA	NA	NA	NA	NA
4.C	Rice Cultivation	NO	NO	NO	NO	NO
4.D	Agricultural Soils	NA	NA	NA	NA	NA
4.F	Field Burning of Agricult. Residues	0.00	0.00	0.00	0.00	0.00
4.G	Other	NA	NA	NA	NA	NA
6	Waste	0.07	0.06	0.06	0.06	0.06
6.A	Solid Waste Disposal on Land	NA	NA	NA	NA	NA
6.B	Wastewater Handling	NA	NA	NA	NA	NA
6.C	Waste Incineration	0.07	0.06	0.06	0.06	0.06
6.D	Other Waste	NA	NA	NA	NA	NA
I.B.	Aviation (cruise)	0.26	0.61	0.62	0.70	0.78

** Data source: Austrian Emission Inventory 2008*

IE … included elsewhere; NA… not applicable; NO … not occurring

2.3 Non-Methane Volatile Organic Compounds (NMVOC)

The emissions of non-methane volatile compounds show a considerable reduction from 1990 to 2007. The main sources of NMVOC emissions in Austria are fuel combustion activities and solvent and other product use; the latter with a share of more than 50%.

Emissions are projected to increase after 2010 due to increased solvent consumption. Improvements of engine technology for mobile sources and the trend towards central heating and lower emission factors of new boilers in the residential sector will not be enough to compensate for this increase.

Table 6: Austria's NMVOC emission projection.

	NEC Gas Source Categories	**NMVOC [kt]**				
		1990*	**2007***	**2010**	**2015**	**2020**
	National Total (fuel sold)	273.64	179.81	167.70	172.45	179.08
	National Total (fuel used)	272.62	175.91	164.31	169.15	176.13
1	Energy	145.07	65.03	56.58	48.99	42.62
1.A	Fuel Combustion Activities	132.86	62.29	54.02	46.61	40.31
1.A.1	Energy Industries	0.42	0.68	0.68	0.68	0.68
1.A.2	Combustion in Manufact. Industry	1.73	2.19	2.92	2.93	2.97
1.A.3	Transport (fuel used)	69.41	17.17	13.30	10.27	8.40
1.A.4	Other Sectors	61.28	42.24	37.10	32.71	28.24
1.A.5	Other	0.02	0.02	0.02	0.02	0.02
1.B	Fugitive Emissions	12.22	2.74	2.57	2.38	2.31
2	Industrial Processes	11.10	4.90	3.97	3.97	3.97
2.A	Mineral Products	IE	IE	IE	IE	IE
2.B	Chemical Industry	8.29	1.32	1.32	1.32	1.32
2.C	Metal Production	0.52	0.49	0.49	0.49	0.49
2.D	Other Production	2.29	3.08	2.16	2.16	2.16
2.G	Other	NA	NA	NA	NA	NA
3	Solvent and other Product Use	114.43	104.09	102.00	114.45	127.81
4	Agriculture	1.85	1.81	1.70	1.69	1.69
4.B	Manure Management	NA	NA	NA	NA	NA
4.C	Rice Cultivation	NO	NO	NO	NO	NO
4.D	Agricultural Soils	1.72	1.70	NA	NA	NA
4.F	Field Burning of Agricult. Residues	0.14	0.11	0.12	0.12	0.12
4.G	Other	NA	NA	1.58	1.57	1.57
6	Waste	0.16	0.08	0.06	0.04	0.03
6.A	Solid Waste Disposal on Land	0.15	0.08	0.06	0.04	0.03
6.B	Wastewater Handling	NA	NA	0.00	0.00	0.00
6.C	Waste Incineration	0.01	0.00	0.00	0.00	0.00
6.D	Other Waste	NA	NA	NA	NA	NA
I.B.	Aviation (cruise)	0.18	0.53	0.55	0.64	0.71

** Data source: Austrian Emission Inventory 2008*

IE … included elsewhere; NA… not applicable; NO … not occurring

2.4 Ammonia (NH_3)

The emissions of NH_3 have slightly decreased since 1990. The main source for ammonia is the agricultural sector contributing more than 90% of the total NH_3 emissions. The trend follows Austrian livestock numbers.

The projections integrate new management options and new emission factors for the Agricultural Sector and thus show a further decrease of emissions in 2010. Emissions are not expected to change significantly after 2010.

Table 7: Austria's NH_3 emission projection.

	NEC Gas Source Categories	NH_3 [kt]				
		1990*	**2007***	**2010**	**2015**	**2020**
	National Total (fuel sold)	71.18	66.41	61.45	61.13	61.01
	National Total (fuel used)	71.15	65.96	61.31	61.04	60.93
1	Energy	4.37	3.14	2.50	2.17	1.98
1.A	Fuel Combustion Activities	4.37	3.14	2.50	2.17	1.98
1.A.1	Energy Industries	0.20	0.38	0.38	0.38	0.38
1.A.2	Combustion in Manufact. Industry	0.33	0.50	0.50	0.49	0.50
1.A.3	Transport (fuel used)	3.21	1.61	1.02	0.70	0.54
1.A.4	Other Sectors	0.63	0.65	0.61	0.60	0.57
1.A.5	Other	0.00	0.00	0.00	0.00	0.00
1.B	Fugitive Emissions	IE	IE	IE	IE	IE
2	Industrial Processes	0.27	0.08	0.08	0.08	0.08
2.A	Mineral Products	NA	NA	NA	NA	NA
2.B	Chemical Industry	0.27	0.08	0.08	0.08	0.08
2.C	Metal Production	IE	IE	IE	IE	IE
2.D	Other Production	NA	NA	NA	NA	NA
2.G	Other	0.00	0.00	0.00	0.00	0.00
3	Solvent and other Product Use	NA	NA	NA	NA	NA
4	Agriculture	66.13	61.66	57.09	57.15	57.22
4.B	Manure Management	58.00	53.47	52.31	52.13	52.04
4.C	Rice Cultivation	NO	NO	NO	NO	NO
4.D	Agricultural Soils	8.08	8.14	4.23	4.47	4.63
4.F	Field Burning of Agricult. Residues	0.05	0.04	0.05	0.05	0.05
4.G	Other	NA	NA	0.51	0.51	0.51
6	Waste	0.38	1.09	1.65	1.65	1.64
6.A	Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00
6.B	Wastewater Handling	NA	NA	0.00	0.00	0.00
6.C	Waste Incineration	0.00	0.00	0.00	0.00	0.00
6.D	Other Waste	0.37	1.08	1.64	1.64	1.64
I.B.	Aviation (cruise)	0.00	0.00	0.00	0.00	0.00

** Data source: Austrian Emission Inventory 2008*

IE … included elsewhere; NA… not applicable; NO … not occurring

3 SOURCES OF DATA

Model calculations are based on custom-made methodologies for the individual sectors. Emissions from Stationary Fuel Combustion and Industrial Processes are based on the National Energy Balance of Statistics Austria and on a macro-economic model of the Austrian Institute of Economic Research (WIFO 2007a), supported by calculations with the bottom-up models BALMOREL, LEAP (AEA) and ERNSTL (EEG) and consistent with (UMWELTBUNDESAMT 2009d).

Projections for Mobile Fuel Combustion were modelled by the Technical University of Graz. Projections for Agriculture were calculated by the Austrian Institute for Economic Research (WIFO 2005b) in cooperation with Umweltbundesamt. Projections for Solvents were calculated by IIÖ & FIEU in cooperation with Umweltbundesamt. Waste projections were modelled by Umweltbundesamt.

A detailed description of the models applied was provided in a report entitled "GHG Projections and Assessment of Policies and measures in Austria", submitted to the European Commission and the European Environment Agency (UMWELTBUNDESAMT 2009d).

The following table presents the main data sources used for activity data as well as information on who carried out the actual calculations:

Table 8: Main data sources for activity data and emission values

Sector	Data Sources for Activity Data	Emission Calculation
Energy	National Energy Balance of Statistics Austria, macro-economic model of the Austrian Institute of Economic Research (WIFO 2005a, WIFO 2005c, WIFO 2007a), bottom-up models BALMOREL, LEAP (AEA) and ERNSTL (EEG) Graz University of Technology (bottom-up, national transport model GLOBEMI)	UMWELTBUNDESAMT (energy providers and manufacturing industries) Austrian Energy Agency – AEA (residential and commercial sector) Graz University of Technology (transport sector)
Industry	Austrian Institute for Economic Research (macroeconomic model MULTIMAC)	UMWELTBUNDESAMT
Solvent	Forschungsinstitut für Energie und Umweltplanung, Wirtschaft und Marktanalysen GmbH and Institut für industrielle Ökologie (bottom-up model)	Forschungsinstitut für Energie und Umweltplanung, Wirtschaft und Marktanalysen GmbH and Institut für industrielle Ökologie
Agriculture	Animal number, fertilizer use, crop- and grassland: Austrian Institute for Economic Research (agriculture model PASMA) (WIFO 2005b)	UMWELTBUNDESAMT
Waste	Landfill database and projection on solid waste to landfill	UMWELTBUNDESAMT

4 METHODOLOGY

4.1 General Approach

Where reasonable and applicable, the emissions were calculated and projected based on the methodology of the Austrian Inventory. The Austrian Inventory is based on SNAP (Selected Nomenclature for sources of Air Pollution) and has to be transformed into the current reporting format under the LRTAP convention – the NFR (Nomenclature For Reporting) format. Thus, projections were also calculated based on the SNAP nomenclature and subsequently transformed into the NFR format.

For all sectors reduction measures were identified and emissions were projected by specifically designed models. The methodology used for the projections of the key driving forces and emission calculations is described in the respective chapters. Consistency between sector models was ensured by regular expert meetings which addressed overlaps and possible gaps.

For this report all implemented measures before August 2008 have been considered for the "with measures" scenario. Emissions from energy related sectors (NFR 1.A) have been calculated on the basis of an energy forecast from 2008.

4.2 General socio-economic assumptions

The general socio-economic assumptions data which form the basis of the Austrian emission projection can be found in Table 9. Further assumptions of key input parameters can be found in UMWELTBUNDESAMT 2009d.

Table 9: Key input parameters of emission projections.

Year	2010	2015	2020
GDP [billion €, 2000]	256.5	287.8	321.7
Population [1 000]	8 427	8 561	8 672
Stock of dwellings [1 000]	3 602	3 725	3 827
International coal prices [€/GJ]	6.59	7.36	7.44
International oil prices [€/GJ]	14.93	14.93	14.93
International gas prices [€/GJ]	9.62	9.62	9.62

4.3 Stationary Fuel Combustion Activities (NFR 1.A)

This chapter describes the methodology used for emission projections of stationary fuel combustion in the NFR sectors 1.A.1, 1.A.2 and 1.A.4.

The output of the model BALMOREL provides fuel-specific activity data for Energy Industries (i.e. Electricity and Heat Production including Waste Incineration). These data were multiplied by the established and fuel-specific emission factors used in the Austrian Inventory. Emission factors for fuels not specified (e.g. for refinery fuel gas, refinery coke) or for wastes (e.g. municipal solid waste, hazardous waste) were derived from plant-specific data.

The methodology for the emission factors is described in the Austrian Inventory Report (UMWELTBUNDESAMT 2009a).

As regards the only refinery operated in Austria, no major changes of production capacities or technologies in use are expected from the current point of view. Restructuring programmes, including the development of new production units, have been undertaken in previous years, with the last one being finished in 2008. Thus the average emission value for the years 2005 to 2007 has been used for the projection. For oil and gas exploration and storage, past trends have been prolonged.

Figures for energy demand were split according to the sub-sectors of the Austrian air emission inventory.

4.3.1 Energy Industry (NFR 1.A.1)

This chapter describes the methodology used for emission projections of stationary fuel combustion in energy and transformation industries.

SO_2 and NO_x

Projected emissions were calculated by multiplying projected energy data (UMWELTBUNDESAMT 2009d) by the respective emission factors. The latter were determined for power plants and waste incineration facilities on a plant specific basis for each fuel type taking into account expansions, commissioning of new plants and closing down of existing facilities.

The detailed description of the methodologies used can be found in the cited literature (UMWELTBUNDESAMT 2003a, b, c), (BMLFUW 2004) and (UMWELTBUNDESAMT & BMLFUW 2002).

NMVOC and NH_3

The NMVOC and NH_3 emissions were assumed to remain constant at 2007 levels (UMWELTBUNDESAMT 2008). This simple approach was chosen because their share in total emissions is less than 1%.

4.3.2 Manufacturing Industry and Combustion (NFR 1.A.2)

This chapter describes the methodology for emission projections of stationary fuel combustion in the manufacturing industry. A methodological description of emission projections for mobile sources in NFR 1.A.2 is given in chapter 4.4.

SO_2 and NO_x

For the estimation of SO_2 and NO_x, both sectors NFR 1.A.2 and 2 were assessed together (UMWELTBUNDESAMT 2003a, c), (UMWELTBUNDESAMT 2007b) and (UMWELTBUNDESAMT 2009b). The following industrial sectors were identified as major sources:

- production in the cement, glass, magnesia, lime and other mineral industry
- iron and steel production
- pulp and paper production
- process emissions of the chemical industry
- wood processing industry
- food industry
- production of non-ferrous metals
- other sectors of the manufacturing industries

Projected emissions were calculated by applying the trend of energy consumption (UMWELTBUNDESAMT 2009d) and incorporating recent data from environmental impact statements such as facility expansions, opening and closing down of facilities.

NMVOC and NH_3

The NMVOC and NH_3 emissions were assumed to remain constant at 2007 levels (UMWELTBUNDESAMT 2008). This simple approach was chosen because their share in total emissions is less than 1%.

4.3.3 Other Sectors (NFR 1.A.4)

This chapter describes the methodology used for emission projections of stationary fuel combustion in the small combustion sector (1.A.4a Commercial/Institutional, 1.A.4b Residential, and 1.A.4c Agriculture/Forestry/Fishing). The methodological description of emission projections for mobile sources in NFR 1.A.4 is given in chapter 4.4.

To calculate energy consumption for stationary sources separately in the subsector residential and commercial, a comprehensive model for buildings is used. A detailed description of this energy model can be found in UMWELTBUNDESAMT (2009d) and TU WIEN (2009).

1.A.4a Commercial/Institutional and 1.A.4b Residential (households)

Based on the energy demand for stationary sources in the subsectors 1.A.4a and 1.A.4b, the SO_2, NO_x, NMVOC and NH_3 emissions were calculated. A full description of the methods and emission factors used can be found in the Austrian Informative Inventory report (UMWELTBUNDESAMT 2009a).

Separate emission factors were used for:

- Fuel type (e.g. coal, natural gas, heating and other oil, residual fuel oil, LPG, wood log & wood briquettes, wood chips and wood pellets)
- Heating type (central heating, apartment heating and stove)
- Different technologies (e.g. new biomass boilers – wood gasification, condensing gas and heating oil boilers)

1.A.4c Agriculture/Forestry/Fishing

Due to its minor contribution to total 1.A.4 energy consumption and its relatively constant trend, the subsector 1.A.4c was calculated in a different way: The mean energy demand over the last few years was extrapolated for each fuel over the forecast period, except for residual fuel oil for which, consistent with sector 1.A.4a, a decrease was assumed.

Consequently, emissions are assumed to change during the forecast period as a result of a technology-based change of emissions factors and a reduction of the demand for residual fuel oil by 2020.

4.4 Mobile Fuel Combustion Activities (NFR 1 A)

In this chapter the methodology used for estimating emissions from sector NFR 1.A.3 (Transport) and from mobile sources under NFR 1.A.2f, 1.A.4 and 1.A.5 is described.

4.4.1 Road/Off-road

The calculation of transport emissions is based on different models:

- Transport demand model

  The transport demand data, which is the basis for emission modelling, results from calculations and forecasts made by a team of authors who also compiled the Austrian "Environmental Balance of Transport" 2006/2008. The Environmental Balance of Transport is a multidisciplinary inter-modal analysis of transport demand in Austria since 1950, and its impact on the environment, human health and the climate.

  Transport volumes for road and rail are based on an amalgamation as well as an analytical synthesis of official background statistics relevant for travel and freight transport demand. Available information such as population data, motorisation rates, as well as vehicle fleet sizes and economic and income development statistics were used. Transport volumes for all other modes (i.e. inland waterways, local buses and trams) were derived from data collected by official Austrian bodies such as "Statistics Austria" (STATISTIK AUSTRIA 2008).

- Road emission model

  For the calculation of road emissions the GLOBEMI model is used (HAUSBERGER, 1998). GLOBEMI was developed for the calculation of emission inventories in larger areas. Input parameters are, amongst others, the vehicle stock in each category (cars, light duty vehicles, etc.), split into layers according to propulsion system (SI, CI, etc.), engine volume or vehicle mass, emission factors of vehicles according to the year of their first registration and the number of passengers per vehicle as well as the tons payload per vehicle. Furthermore, the model delivers an assumption of the fuel export effect.

- Off-road emission model (1.A.2f, 1.A.3c, 1.A.3d, 1.A.4b, 1.A.4c, 1.A.5)

  Energy consumption and off-road emissions in Austria are calculated with the model GEORG ("Grazer Emissionsmodel für Off Road Geräte") (PISCHINGER 2000). The model GEORG has a fleet model part, which simulates the actual age and size distribution of the vehicle stock via age- and size-dependent drop-out rates (probability of a vehicle being scrapped by the next year). With this approach the stock of each category of mobile sources is calculated according to the year of first registration and the propulsion system (gasoline 4-stroke, gasoline 2-stroke, diesel > 80 kW, diesel < 80 kW).

The following input parameters are used for road/off-road emission projections:

4.4.1.1 Emission factors

Road transport

Emission factors from EURO 0 to EURO 4 are based on measurements. Emission factors for EURO 5 and EURO 6 are expert assessments.

Off-road machines

The emission factors are based on a new off-road study commissioned by the Umweltbundesamt (HAUSBERGER & MACHER 2008).

4.4.1.2 Vehicle stock (passenger cars), motorisation rate

The vehicle stock is counted annually and serves as input for the motorisation rate. Another yearly statistical input is the population number. The transport model is based on the following assumptions concerning the motorisation rate.

Table 10: Vehicle stock and motorization [cars per 1 000 inhabitants].

	Vehicle stock	Motorisation rate
2003	2 785 962	363
2005	4 054 308	499
2010	4 156 743	505
2015	4 656 930	555
2020	5 030 070	588

4.4.2 Aviation

The projection of energy consumption and emissions is an extrapolation of the trend in the latest years. Between 2010 and 2020 the annual growth rate (of energy) is assumed to be 2.1%.

4.5 Fugitive Emissions (NFR 1 B)

SO_2 and NMVOC

SO_2 and NMVOC emissions projections from Fugitive Emissions are based on 2003 emission/activity data ratios, as well as projected activity data such as natural gas and crude oil exploration and natural gas consumption according to (WIFO 2005a). Emission reduction measures such as the introduction of vapour recovery units at depots and service stations were implemented in 2003 already and no further reductions are expected.

A detailed description of the methodology of emission estimation can be found in the Austrian Informative Inventory Report 2009 (UMWELTBUNDESAMT 2009a).

NO_x and NH_3

Emissions are not estimated in the Austrian inventory and have therefore not been incorporated in the projections.

4.6 Industrial Processes (NFR 2)

The forecast for the developments of industrial production was based on macro-economic data for the sub-sectors (UMWELTBUNDESAMT 2009d), taking into account known predictions about expansions in iron and steel production (VOESTALPINE STAHL 2007), and the opening of new installations and decommissioning of old facilities for sulphuric acid production.

NO_x and NMVOC emissions from 2.D.1 Pulp and Paper are reported together with energy-related emissions under 1.A.2f Other.

SO_2 and NO_x

The methodology used for calculating SO_2 und NO_x is described in Chapter 4.3.2.

NMVOC and NH_3

NMVOC and NH_3 emissions were assumed to remain constant at the levels of 2007 (UMWELTBUNDESAMT 2008). This simple approach was chosen because their share in total emissions is less than 1%.

4.7 Solvent and Other Product Use (NFR 3)

NMVOC

The forecast of activities is modelled on data from the macroeconomic model from WIFO (WIFO 2007a) and the "Environmental Balance of Transport" 2006/2008" GLOBEMI model (HAUSBERGER 1998). In the period 2007–2020 it is expected that the solvent activities (solvents and solvent containing products) will increase by 7% if the GDP (at current prices) increases by 44%.

Data in the Austrian air emission inventory 2008 are based on surveys (WINDSPERGER et al. 2002a, b; WINDSPERGER et al. 2004, WINDSPERGER & SCHMID-STEJSKAL 2008), import-export statistics (foreign trade balance), production statistics provided by Statistics Austria and plant-specific data.

For 2007 the quantity of solvents (activity data) used in Austria in various applications has been determined by a combination of a bottom-up and a top-down approach.[1] The solvent content in products and preparations (for 2007), given as a ratio of the amount of imported products and the amount of solvents in the products, is included in the solvent model (WINDSPERGER & SCHMID-STEJSKAL 2008). The quantity of solvents is disaggregated on SNAP level 3 according to the solvent model and the forecast is made in correlation with the GDP growth forecast (at current prices) of the corresponding NACE Codes rev.1.1., provided by the macroeconomic model from WIFO (WIFO 2007a).

The same emission factors as in 2007 were used for the forecast, because only minimal positive impacts of the enforced laws and regulations are expected in Austria for subsequent years. The emission factors are calculated by solvent use per substance category at NACE-level-4 of all industrial branches and are based on information from surveys in households and industry as well as structural business statistics.

NO_x, SO_2 and NH_3

According to the Austrian inventory there is no occurrence of NO_x, SO_2 and NH_3 emissions from solvent use.

4.8 Agriculture (NFR 4)

The required activity data was obtained from the agricultural sector model PASMA (WIFO 2005b). PASMA was employed to estimate livestock population, the use of mineral fertilizers and the development of cropland and grassland. The model is based on the method of positive mathematical programming (PMP). This approach is a mathematical non-linear projection model which allows flexible adaptations to new conditions.

[1] A comprehensive summary on the methodology for the base year 2007 and an exhaustive list of implemented measures in the Solvent sector can be found in the Austrian Informative Inventory Report (IIR) 2009 (UMWELTBUNDESAMT 2009a).

Scenario assumptions and the results of the PASMA model were supported by the following agricultural experts:

- DI Elmar Ritzinger, BM für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Abteilung II/9: Investitionen und Marktstruktur
- DI Sonja Schantl, BM für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Referat III/9b
- DI Rupert Lindner, Landwirtschaftskammer Österreich, Referat III/1, Pflanzliche Erzeugnisse
- DI Alfred Pöllinger et al., Federal Research Institute for Agriculture in Alpine Regions, A-8952 Irdning (BAL GUMPENSTEIN 2004) (BAL GUMPENSTEIN 2005)

The following policy measures are considered implemented ("with measures" scenario)

- Implementation of the CAP 2003 reform; special attention is given to the Austrian variant of implementation (keeping the premiums for suckler cows – including heifers – and part of the slaughter premiums; allocation of premium rights to farmers);
- Due to uncertainties concerning the flow of funds from "modulation", we assumed that the amount that Austrian farmers who might be beneficiaries receive is the same as the one that other farmers lose through this measure;
- Land is maintained in good agricultural and ecological condition ("cross compliance");
- The programme for rural development remains unchanged.

4.8.1 Overview of the PASMA "with measures" scenario results

Livestock

- The number of livestock – in particular cattle – will get smaller because of reduced production incentives (premiums per head will be decoupled for bulls);
- The number of suckling cows will be less affected because premiums per head will be coupled to production even after the reform in Austria; a given share of heifers qualifies for such premiums as well, therefore the number of suckler cows and heifers is relatively constant;
- Since farmers will get coupled premiums either for suckling cows or heifers - but other premiums for cattle will be abandoned, the population of suckling cows will not necessarily increase (the reason being that the model takes account of the profitability of the whole cattle production simultaneously) and an implication here is that the value of calves will drop;
- Our results suggest that the additional premiums for Austria will amount to a windfall for farmers producing heifers already (assuming that the market for premium suckler cow premium entitlements is working efficiently)
- The consequence of lower prices for pork and poultry and lower feeding costs is that the output of none of these products will be expanded – this being a consequence of the modelling approach taken in this analysis;
- Therefore, less or no substitution of supplies of beef by other meat is expected;
- According to the model type used for this analysis, changes of pork and poultry production will be "0" under such circumstances;

Milk Yield

The volume of milk production is determined by the national quota which will be expanded in two steps and which will be fixed from 2008 onwards; since some of the share of milk is used as animal feed, production also depends on its nutritional value relative to the production cost of increasingly productive milk cows.

Organic Farming

Organic farming will become more attractive for farmers, mainly because of the assumption that premiums of the agri-environmental programme will stay in place, with prices of organic products being higher while opportunity costs will be lower after the implementation of the reform.

Synthetic Fertilizer Use

An agricultural sector model (PASMA, developed by WIFO) was employed to estimate the use of mineral fertilizers. The model was used to evaluate the reform of the Common Agricultural policy and further developments and for trend scenarios with the implementation of Water Framework Directive (WIFO 2004) in other studies.

In the model, input requirements (and thus fertilizer demands) are evaluated at the nutritional level. The calculations mimic farmer behaviour, allowing for substitution between nutrients purchased on the market (commercial fertilizer), nutrients accumulated by crops (legumes) and animal waste containing nutrients (manure).

Agricultural Cropland

PASMA is a model which is calibrated using observed conditions during a base period. Therefore the model results are fully consistent with observations from official statistics. In the model, the economic accounts of agriculture (EUROSTAT 2000) are used as a benchmark. Therefore crop allocations in the model are identical with those of official statistics during the base period.

In the forecast period, the model assumes that farmers choose to farm land according to the microeconomics of individual behaviour based on profit maximisation. In the model, all relevant farm policies are accounted for in a very detailed manner. Therefore the model is capable of considering support schemes for organic farming as well. This type of farming uses legumes to accumulate nutrients and the model considers this by incorporating nutrient balances.

Grassland

Grassland and arable land are treated similarly in the model: all relevant activities and policies affecting decisions on land allocation are accounted for. Given the recent reform of the Common Agricultural Policy, one important consequence is that the share of land used for agricultural purposes will be more or less frozen in the decade to come. In the past it was observed that a considerable part of land was afforested. According to the model results this trend will decline because "cross compliance" requirements will force farmers to maintain farm-land in good agricultural condition. A considerable part of the land previously used for arable crops will be turned into grassland, which will expand as a consequence.

4.8.2 Emission calculation

Emissions are calculated following the revised methodology used for the Austrian inventory 2009 where new management options and new emission factors had been integrated (AMON & HÖRTENHUBER 2008). Considered manure treatment options had been extrapolated to the year 2010 and then held constant for 2015 and 2020.

A comprehensive description can be found in Austria's next Informative Inventory report 2010.

4.9 Waste (NFR 6)

NMVOC and NH_3 from Waste Disposal

NMVOC and NH_3 emissions are calculated by keeping the ratio to CH_4 emissions the same as for 2007, as in the Austrian Inventory 2008 (UMWELTBUNDESAMT 2008) on which the projections are based. Projections of CH_4 emissions are calculated by means of projected waste generation rates, an assumed share and degradable carbon content of waste and a share of recovered waste gas.

A detailed description of the methodology used for the calculation of projections of CH_4 emissions can be found in Austria's projection of greenhouse gases, submitted to the European Commission under the EU Monitoring Mechanism (UMWELTBUNDESAMT 2009d).

NO_x, SO_2, NMVOC and NH_3 from Waste Incineration:

Because of the low contribution to the total emissions (below 1% for all gases), emission levels from the year 2007 were applied for the forecast. A detailed description of the methodology used for the emission estimation can be found in the Austrian Informative Inventory Report 2009 (UMWELTBUNDESAMT 2009a).

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The report "Austria's National Air Emission Projections 2010–2020" presents emission projections reported under the UN/ECE Convention on Long-Range Transboundary Air Pollution. It includes projections for the air pollutants NO_x, SO_2, NMVOC, and NH_3 for the years 2010, 2015, and 2020.

The projections for NO_x show further decrease of emissions until 2020. For Ammonia further decrease of emissions in 2010 followed by a constant trend is reported. For SO_2 no further significant reductions are expected. NMVOC emissions are projected to increase after 2010.

The results are based on a scenario which accounts for all measures implemented before August 2008 ("with measures" scenario). Emissions from energy related sectors are calculated on the basis of an energy forecast from 2008 and do therefore not reflect recent economic developments.

EMAS
Geprüfte Information
REG.NO. AT-000484

ISBN 978-3-99004-061-4